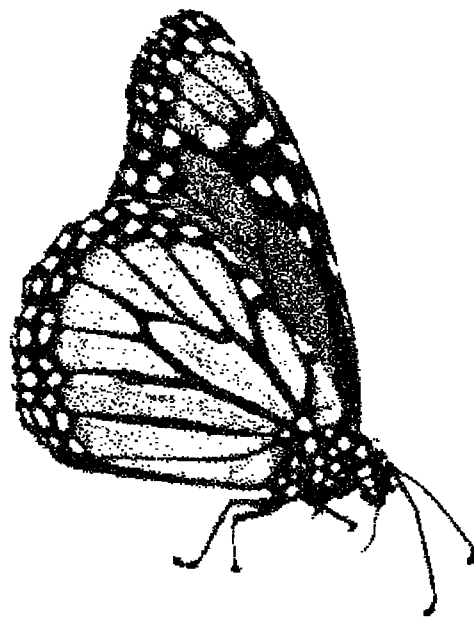


Butterfly Monitoring Protocol for Four Prairie Parks

Northern Prairie Wildlife Research Center Inventory and Monitoring Protocol



U.S. Department of the Interior
U.S. Geological Survey

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U.S. Department of the Interior
U.S. Geological Survey

Butterfly Monitoring Protocol for Four Prairie Parks

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PREFACE

The original draft of the Butterfly Monitoring Protocol for Four Prairie Parks was synthesized by Drs. William M. Rizzo and Gary D. Willson from the completion reports on the butterfly species inventories in the four parks prepared by Mr. Scott Mahady and Dr. Diane Debinski and from the completed thesis of Mr. Mahady.

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1.0 INTRODUCTION

1.1 Background

Habitat loss and fragmentation are two of the primary factors leading to species extinctions during this century. Tallgrass prairie habitat in the Midwestern United States has been particularly affected. Only about 1% of the original tallgrass prairie ecosystem still remains (Swengel 1996). The drastic loss of prairie habitat, the disruption of natural disturbance regimes and nutrient cycles, and the isolation of the remaining tallgrass prairie habitat makes the preservation of prairie-dependent species a unique challenge (Johnson and Simberloff 1974; Leach and Givnish 1996; Collins et al. 1998; Kaiser 1998; Schlicht and Orwig 1998).

The butterfly communities of tallgrass prairie remnants can be viewed as indicators of ecosystem health, much like aquatic macroinvertebrates have long been used as indicators of water quality. In addition, the butterfly communities can serve as potential indicators for impacts on a broader spectrum of invertebrate species (New et al. 1995). As an indicator group, butterfly communities offer several advantages: 1) Their habitat preferences and host plant associations are relatively well-known, which allows classification of individual species into guilds (Sharp et al. 1974; Scott 1986; Opler and Malikul 1992; Panzer et al. 1995; Swengel 1996; 1998); 2) Much literature exists on metapopulation dynamics, dispersal, and the effects of different habitats on butterfly movement behavior (Sharp et al. 1974; Fahrig and Paloheimo 1987; Hanski et al. 1995; Hanski et al. 1996; Hill et al. 1996; Neve et al. 1996; Peterson 1997; Haddad 1999); and 3) Obligate prairie species respond quickly to changes in native vegetation (Miller and Harris 1977; Saunders et al. 1991).

While this protocol was developed to monitor the butterfly community to determine the status of the ecosystem health of the existing habitat types, butterfly monitoring also could be used to evaluate the impact of management practices or extraordinary natural events. These could include evaluations of practices such as prescribed fire, mowing, herbicide application, or grazing, or impacts caused by natural events such as flooding or invasion of exotic species.

With the growing emphasis on ecosystem management, the National Park Service (NPS) must possess protocols for monitoring the status of butterfly communities within an ecosystems context. This protocol was developed for use by four of the national parks within the Great Plains Prairie Cluster Long-Term Ecological Monitoring Program (hereafter referred to as the Prairie Cluster Program). Two of the four parks, Pipestone National Monument (PIPE) in Minnesota, and Homestead National Monument of America (HOME) in Nebraska have both restored and native tallgrass prairie. The other two parks, Wilson's Creek National Battlefield (WICR) in Missouri, and Effigy Mounds National Monument (EFMO) in Iowa, have restored and native tallgrass prairie and oak savanna/woodland. WICR also has glade habitats.

1.2 Objectives of butterfly monitoring

Butterfly communities were chosen to serve as indicators of ecosystem health for prairie, savanna/woodland and glade habitats. Butterfly monitoring allows park managers to detect and describe long-term changes in the butterfly communities associated with these habitats. Specifically, the monitoring objectives are: 1) to quantify temporal changes in the species composition, abundance, and richness of butterfly guilds for selected habitats in each park; and 2)

to quantify differences in the species composition, abundance, and richness of butterfly guilds among park habitats. The spatial analyses also can be used by park managers to assess the effectiveness of management practices such as prescribed fire or to evaluate the success of restored prairie compared to native prairie remnants.

2.0 PROTOCOL DESIGN

2.1 Sampling methods

This protocol basically follows the procedures described in Mahady (1999), which are modified from the transect technique described by Pollard (1977). Unintrusive transect surveys such as the “Pollard walk” are adequate and efficient for monitoring butterfly communities, especially in protected areas such as national parks where rare species are known to occur (Murphy 1988). Furthermore, the fixed transects of Pollard walk counts are uniform with respect to area covered and time spent, which allows more rigorous statistical analysis (Royer et al. 1998). The fixed nature of the transects also allows for concurrent monitoring of other natural resources such as the plant community. Pollard transects typically use count data to monitor abundance of butterfly species (Swengel 1996) and species richness (Mahady 1999).

2.2 Sampling sites

Each park unit was sampled in 1997 and 1998 to inventory the butterfly community and propose management recommendations to the resource managers. These parks were chosen for butterfly monitoring because prairie plant community studies within fragmented habitats also were ongoing in these parks. Within each park, sampling was carried out along transects in different habitat types, which varied among the different parks. The habitat types sampled in each park are shown in Table 1 (Mahady and Debinski 1999a; 1999b; 1999c; 1999d). Each transect is 5-m wide by 50-m long. The transect length was established for conformity with vegetation sampling (Buck et al. 2000; Anonymous 1993) so that possible future analyses of butterfly/plant relationships could be made.

In 1998, where possible, 6 transects were placed in each habitat parallel to previously established plant community transects which had been located randomly (Mahady 1999). In 1999, two additional transects were sampled in some prairies large enough to accommodate them (Mahady 1999). Subsequent analyses (see section 2.3) indicated that six transects are sufficient for sampling prairies the size of those listed in Table 1. All available transect locations are shown in Appendix A. Transect locations for EFMO are not available.

In prairies larger than 4 ha, butterfly transects were located at least 50 m apart. In smaller prairies, the size and shape of the habitat dictated the placement of transects. In these areas, the transects were located to maximize both the distance between transects and the distance from the habitat edge. Transects occasionally had to be curvilinear to be accommodated within a habitat type. In an extreme case (North Bloody Hill at WICR), the habitat was so fragmented that the transects consisted of sampling the entire area. In Appendix A, transect locations for this site are actually count points. In a number of areas, 6 or fewer 50 m transects were all that could be accommodated within the habitat (native prairie at HOME; all sites at EFMO). The number of transects recommended for sampling in each park and habitat is shown in Table 1.

2.3 Sampling intensity

Some of the data collected by Mahady (1999) were analyzed to assess the adequacy of the number of transects. The number of species from one transect randomly selected from the dataset was used to represent “transect 1” for a given sampling date. A second randomly selected transect was added to the first transect to represent “transects 1 and 2” (i.e. sampling without replacement). This process was repeated until all the data from the 6 transects were recorded. This process was undertaken 20 times, and the mean results are shown in Figure 1 for several sites. These results showed that for parks similar in size to most of those used in the development of this protocol, 85% of the taxa present were recorded by sampling only 3 to 4 transects, so 6, 50-m transects were more than adequate for this sampling effort. These results also suggest that for very large parks such as Tallgrass Prairie National Preserve, 6 transects are not adequate. For larger parks, 8 or more transects should be initially established, and their adequacy should be evaluated by a method similar to that described above.

2.4 Sampling frequency and timing

Emergence periods (i.e. flights) for some butterfly species are brief, but individuals may be very abundant. For instance, Mahady (personal communication) reported 101 sightings of the powesheik skipper at PIPE on 27 June 1998, but none on 26 June 1997, probably because the 1997 flight was slightly earlier. To increase the likelihood of capturing such ephemeral flights, especially for species with different emergence dates during the year, transects should be sampled four times during the growing season. This doubles the sampling effort used by Mahady and Debinski (1999a; 1999b; 1999c; 1999d), but the objectives of those studies were different than the goals of this monitoring protocol. The sampling windows suggested for the various parks are shown in Table 2. These windows were selected based on previous sampling experience (Mahady and Debinski 1999a; 1999b; 1999c; 1999d) and analysis of the typical emergence times of butterfly species (Richard and Heitzman 1987).

Certain minimum weather conditions also are required for an adequate sample. Butterfly flight activity is decreased by cool temperatures or heavy cloud cover. Cloud cover is not as important a limitation as temperature, so the percentage of cloud cover can become relatively high and not limit butterfly activity if the temperature also is high. The temperature must exceed 18°C, and cloud cover must be less than 70%. If cloud cover exceeds 70%, the temperature must exceed 23°C. Surveys must be conducted on days when wind gusts are less than 45 kph (30 mph) or on days with prevailing winds less than 30 kph (20 mph). There are no standard guidelines for sampling constraints, but the limits recommended here are similar to those used by other butterfly researchers (Pollard 1977; Ron Royer, personal communication, uses 50% cloud cover, 16°C, and Beaufort scale < 4); (i.e. < 20 km h⁻¹), and their continued use will ensure consistency in the physical conditions for data collection. Surveys are conducted between 0900 and 1730 hrs, because butterfly activity is low before 0900 due to cooler temperatures.

Temperatures are determined using a stem field thermometer placed in the shade under vegetation. This will underestimate actual temperature, and, therefore, is a conservative approach to sampling during periods of butterfly activity. Cloud cover is a visual estimate of the percentage

of clouds obscuring the sky, excluding the lower 30° from the horizon upward on all sides of the observer (resulting in a total of 120° of sky for the estimate). Wind speeds are determined in the field with a wind meter (e.g. Wind Wizard®).

3.0 FIELD IMPLEMENTATION

3.1 Field sampling

A list of supplies and equipment used for butterfly monitoring is given in Table 3. Prior to sampling (the day prior to sampling at the latest), the transects should be flagged every 10 m along each boundary of the 5-m transect width. The observer then walks down the middle of the transect. The 2.5-m distance on either side of the observer is the maximum distance for reliable visual identification (Pollard 1977). All butterflies are identified by a single observer walking at a constant pace of 10-m per minute. A stopwatch is used to ensure the correct speed is followed. The timing is stopped whenever additional time is needed for capture and identification of some individuals or when large numbers of individuals are encountered. The observer identifies all individuals to species except for individuals of the genus *Phyciodes*, which are difficult to identify to species in the field. Extra care also should be taken in identifying species of the genera *Erynnis* and *Thorybes*, but they can be adequately identified to species in the field. Individual butterflies that cannot be identified in flight are captured using a standard butterfly net and then identified. The number of individuals of each species encountered during each count is recorded on a data sheet (Table 4) along with the number of counts made on each transect. The example in Table 4 includes the entire park species list by guild (Mahady and Debinski 1999c). The observer also should carry the entire species list compiled by Mahady and Debinski (1999a; 1999b; 1999c; 1999d) for aid in identifying new species. In addition to the entire species list for the four parks, this list also contains species that were found in prairies outside the parks and that would likely be encountered in future sampling within the parks.

Each transect is surveyed 6 times during a sampling visit for a total walking time of 30 minutes at the required pace. A minimum of 15 minutes should elapse between counts to allow the butterfly community to recover from the disturbance of the previous sample. If there are other habitat transects nearby, these can be sampled during the waiting period. Since the total walking time for a transect is just 30 minutes, the waiting period increases the temporal span of the counts to 2 hrs, which allows for incorporation of some diel effects on the activity of different butterfly species. Repeated surveys, rather than a single extended count, are recommended because uncommon species were occasionally tallied during later counts (Mahady, personal observations) and because the actual identification and enumeration time is extended as needed when the observer is not walking.

Butterfly species respond differently to the effects of sampling disturbance. Some species will be largely unaffected, yet others may be driven away. However, because these behaviors can be assumed to be constant from year to year and because the focus of the protocol is to detect changes over time, any sampling bias introduced by disturbance should not affect the outcome of the protocol sampling objectives. Sampling should be undertaken by personnel with advanced training (e.g. Master's degree) in entomology with special training in butterfly taxonomy. The field guides with the greatest relevance to these parks are Richard and Heitzman (1987) and Glassberg (1999).

3.2 Additional field data collection

The physical field conditions under which the butterfly counts are made also are recorded on the data sheet (Table 4) in order to assess the possibility that weather conditions may have affected survey results. Air temperature (°C), wind speed (kph), wind gusts (kph), and cloud cover (%) should be recorded prior to sampling and again after sampling is completed.

Butterfly population dynamics are intimately tied to plant community dynamics. While there may be important interannual differences in plant phenology (e.g. flowering time), plant community data collected to date indicate that the plant community is composed primarily of perennial species that show few interannual differences in community composition (DeBacker et al. 1998; DeBacker 1999). However, long-term successional changes are likely in disturbed habitats. Park managers interested in maintaining native plant diversity must also understand the status and trends of prairie plant communities. The Prairie Cluster Program is nearing completion of a protocol for monitoring plant communities. This protocol describes the collection of percent foliar cover of all herbaceous and shrub species and basal area for trees using fixed plots sampled in late spring/early summer and late summer. Metrics such as Shannon diversity and species richness then are calculated from the data to allow detection of changes from year to year and from a baseline year (Buck et al. 2000). Plant community monitoring programs have been established at the parks used for butterfly sampling. Other parks or areas wishing to monitor butterfly communities also should establish a plant community monitoring program. A weather monitoring program (e.g., Akyuz et al. 2000) also can provide valuable insights into butterfly community dynamics.

4.0 CALCULATION OF METRICS AND STATISTICAL TESTING

4.1 Butterfly metrics by guild and habitat type

Each butterfly species in the baseline dataset is tabulated by ecological guild in Table 5. The classification of butterfly species as prairie obligates is based on a large body of research (Scott 1986; Opler and Malikul 1992; Panzer et al. 1995; Swengel 1996; Schlict and Orwig 1998). The relative dependence of other butterfly species on particular habitats is less well-known and was derived from general descriptions of the species (Scott 1986; Opler and Malikul 1992).

The total abundance of the species comprising each guild can be tested among years or time periods using repeated-measures analysis of variance and multiple range testing (e.g., Duncan's test) because transects are permanently fixed. Comparison of different sites also may be carried out using analysis of variance. The data should first be tested for compliance to the assumptions of normality and homoscedasticity required for parametric analysis of variance (SAS Institute Inc. 1989-1996). Data transformations (e.g., log, rank, square root) may be required. If the data cannot be adequately transformed, non-parametric analyses analogs of analysis of variance, such as the Kruskal-Wallis test, can be used. Non-parametric tests are less sensitive to data outliers, which greatly contribute to heteroscedasticity. High variability can occur in butterfly surveys due to low abundance values, infrequent occurrence (i.e., locally rare species), or patchy distributions.

Species richness is simply the sum of the number of species, by guild, recorded for a transect on a given date and habitat. High butterfly species richness is indicative of high quality habitat, i.e. habitats with high vegetative diversity. Species richness also can be used to assess changes at a site over time or to compare the richness of restored prairies to native prairies (Selser 1992). Species richness also is analyzed by the procedures used for analyzing the abundance data. In addition, an easy way to compare the species richness in pairs of habitats, or pairs of time periods, is through the use of similarity coefficients such as the Jaccard index (Smith 1990).

It is calculated as:

$$SC_j = c/(A + B - c),$$

where c equals the number of species found in both habitats, A equals the total number of species in habitat A, and B is the total number of species in habitat B. Values range from 0 (no species common to both) to 1 (all species occur in both habitats). Thus, while richness may indicate good habitat diversity, it could be possible that the butterfly community composition in two equally diverse areas arises from totally different community composition. Use of similarity indices can thus augment the species richness information by offering a way to evaluate a data set in reference to a desired target (i.e., a native prairie butterfly community).

4.2 Long-term data analyses

Ultimately, the goal of monitoring efforts should be the detection of changes in community attributes over time. For example, one might wish to detect a 20% change in abundance with 90% confidence. It is intuitive that changes should be detectable before changes become great enough to result in adverse impacts. However, the magnitude of these changes causing adverse impacts are largely unknown. In addition, efforts to assess sampling adequacy, (e.g., power analysis) need to be based on enough years of data to incorporate the full range of interannual variability of the parameter. Because butterfly abundances may change several orders of magnitude between years, it is highly unlikely that application of techniques such as power analysis to two years of available data (Mahady 1999) is likely to result in a useful recommendation of sampling effort. A more reasonable approach would be to continue butterfly monitoring and address this question when additional years of data are available for analysis. A minimum of 5 years of annual data should be collected and analyzed to assess sampling adequacy. However, a final consideration is that techniques for estimating required sampling effort may not be very realistic in an ecological sense. In a number of cases within these four parks, essentially the entire habitat was surveyed so that additional transects could not be added regardless of the results of power analysis.

5.0 DATA MANAGEMENT

5.1 Database design

Original data sheets with the butterfly count data and the data on the physical variables should be stored at the Prairie Cluster Program office. If a contractor carries out the monitoring,

the contractor should keep a copy of the original data sheets.

The Prairie Cluster Program office uses a Microsoft® Access database to store the long-term archive, though other statistical or spreadsheet programs also can be used. If other storage media are used, however, it is important for continuity or “institutional memory” that metadata descriptions be incorporated into the data-storage process. The data within the Access database cannot serve as a direct medium for data input into statistical packages. The database must be queried to compile a table of the required data, which is exported into a suitable spreadsheet format that then serves as the input for the statistical package.

The Access butterfly database is designed for compatibility with other Prairie Cluster Program monitoring databases, so it incorporates standardized site and event information. The database comprises 6 tables in a relational design (Table 6). Tbl_Butterfly_Data contains the abundance (count) data by species, with alphanumeric codes identifying site, sampling event (date), and species information. Related site, event, taxa, and weather (field data) tables are associated with Tbl_Butterfly_Data through “one-to-many” controlled links. These linkages impose referential integrity between the core data and related information, ensure data quality, and provide for easy incorporation of data updates. For example, only after all sample event and investigator data have been entered could a particular sample event for data entry be selected. Additionally, the database linkages can speed data entry. For instance, a species guild assignment is updated in a single location in Tbl_Butterfly_Species rather than for each species (potentially hundreds).

The data stored in Tab_Site, Tbl_Event, Tbl_Butterfly_Species, Tbl_Butterfly_Guilds, and Tbl_Weather are shown in Table 6. Tbl_Site includes UTM coordinates for the sampling sites, where available, and other descriptive information. Tbl_Event includes sampling dates, investigator names, and field notes. Tbl_Weather contains the physical field data collected along with the butterfly abundance data. Tbl_Butterfly_Species includes scientific names, guild assignments, and taxon codes. Tbl_Butterfly_Guilds contains butterfly guilds descriptions. A 6-letter code is assigned to each butterfly taxon during data entry. It consists of the first 3 letters of the genus name and the first 3 letters of the species name. In case of a duplicate code for a new species, the first letter of the species name resulting in a different code is used. Taxon codes are necessary for data manipulation in many spreadsheet and statistical packages that do not allow long variable names.

5.2 Data entry and checking

The database must be updated as new data are acquired, which can result in significant numbers of transcription errors. To reduce transcription errors, data entry is accomplished by using customized forms that prevent entry of duplicate or incorrect taxonomic records. There is a unique identification value for each site/date combination. Most other variables can be selected from drop-down menus. Each species entry is selected from drop-down menus and linked to the Tbl_Taxa so that only valid species names can be entered into the database, which eliminates typographic mistakes. If a species name is not accepted, it is probably either a species new to the database or the result of a nomenclature change. A nomenclature update form is attached via a button to allow quick checking for the current accepted name. If a species is not presently included in the taxa table, a form is available to update this table with the new attribute data.

Data verification occurs immediately after data entry by checking the accuracy of the computerized records against the original sources. Someone familiar with butterfly taxonomy should do the manual verification. In addition, database queries can help validate the accuracy and completeness of the database after all the season's data entry has been made. The query should search records with a site code from one park and an event code from a different park.

5.3 Annual reports

An annual report should be prepared giving the results from each park for each year of sampling. The report should present the results of the abundance and species richness analyses for the butterfly guilds for each park habitat. Reports also should describe the physical conditions under which the data were collected. An example report is given in Appendix B.

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Table 1. Habitat types and recommended number of sampling transects per habitat in four parks of the Prairie Cluster Program. * indicates sites containing the maximum possible number of transects.

Park/Habitat	Number of transects
Effigy Mounds National Monument	
Restored prairie	2*
Goat prairie	6*
Homestead National Monument of America	
Restored prairie	6*
Schoolhouse native prairie	6*
Pipestone National Monument	
Restored prairie	6
Native prairie	6
Native prairie with rare orchids	2*
Wilson's Creek National Battlefield	
Bloody Hill (glade/woodland)	6
North Bloody Hill (glade/woodland/grassland)	surveyed in its entirety
Upland savanna	4*
Ray House restored prairie	2*

Table 2. Recommended temporal sampling windows in four parks of the Prairie Cluster Program.

Effigy Mounds National Monument			
May 12-17	June 15-25	July 2-8	August 1-6
Homestead National Monument of America			
May 3-9	June 7-15	July 20-28	August 18-24
Pipestone National Monument			
May 18-26	June 26-July 2	July 8-13	August 7-16
Wilson's Creek National Battlefield			
April 4-30	May 28-June 5	July 13-18	August 26-31

Table 3. Equipment and supplies necessary for butterfly monitoring.

For laying out transects:

- tape measure
- flags

For butterfly counting and identification:

- 46 cm (18 in) diameter aerial net (e.g. from Bioquip®)
- park species list
- total species list for all parks
- data sheets
- pencils
- field guides
- stopwatch

For additional data collection:

- wind meter (e.g. Wind Wizard ®)
- stem thermometer

Table 4. Field data sheet for recording butterfly count data and weather data.

Date: 1 June 1999

Park name: Pipestone NM

Start time: 1000

Temperature: 20 °C

Wind speed: 5 kph

Wind gusts: 10 kph

Cloud cover: 10%

End Time: 1400

Temperature: 23 °C

Wind speed: 10 kph

Wind gusts: 15 kph

Cloud cover: 30%

Site/habitat type: Restored prairie

Surveyor(s): _____

Transect: _____

Counts:	1	2	3	4	5	6

Species

Common name

Taxon code

Number of individuals

Open habitat generalist species

Colias eurytheme

alfalfa butterfly

COLEUR

Colias philodice

clouded sulfur

COLPHI

Danaus plexippus

monarch

DANPLE

Euptoieta claudia

variegated fritillary

EUPCLA

Everes comyntas

eastern-tailed blue

EVECOM

Hemiargus isola

Mexican blue

HEMISO

Phyciodes tharos

pearl crescent

PHYTHA

Pieris rapae

cabbage

PIERAP

Vanessa atalanta

red admiral

VANATA

Vanessa cardui

painted lady

VANCAR

Wallengrenia egeremet

broken dash

WALEGE

Table 4. Continued.

Transect:	1	2	3	4	5	6
Counts:						
Species	Common name	Taxon code	Number of individuals			
Grassland specialist species						
<i>Coenonympha tullia</i>	ringlet	COETUL				
<i>Papilio polyxenes</i>	black swallowtail	PAPPOL				
<i>Plebejus melissa</i>	melissa blue	PLEMEL				
<i>Polites themistocles</i>	tawny edged skipper	POLTHE				
<i>Speyeria atlantis</i>	atlantis fritillary	SPEATL				
Prairie obligate species						
<i>Oarisma powesheik</i>	powesheik skipper	OARPOW				
<i>Speyeria aphrodite</i>	aphrodite fritillary	SPEAPH				
<i>Speyeria idalia</i>	regal fritillary	SPEIDA				
Woodland species						
<i>Ancyloxypha numitor</i>	least skipperling	ANCNUM				
<i>Cercyonis pegala</i>	common wood nymph	CERPEG				
<i>Euphyes vestris</i>	dun skipper	EUPVES				
<i>Papilio glaucus</i>	tiger swallowtail	PAPGLA				
Wetland specialist species						
<i>Lethe eurydice</i>	northern pearl eye	LETEUR				
<i>Polites mystic</i>	long dash	POLMYS				

Table 5. Butterfly species by guild in four prairie parks and adjacent prairies during 1997 and 1998. WICR = Wilson's Creek National Battlefield, HOME = Homestead National Monument of America, EFMO = Effigy Mounds National Monument, and PIPE = Pipestone National Monument. Species with no park indicated were recorded during sampling of other nearby prairies (Mahady 1999). Guilds are coded as HG = open habitat generalist species, GS = grassland specialist species, PO = prairie obligate species, WS = woodland species, WE = wetland specialist species, and SS = savanna specialist species.

Species	Common name	Taxon code	Parks where present	
Open habitat generalist species				
<i>Atalopedes campestris</i>	sachem	ATACAM	WICR	
<i>Celastrina argiolus</i>	spring azure	CELARG	WICR	HOME EFMO
<i>Chlosyne nycteis</i>	silvery checkerspot	CHLNYC	WICR	
<i>Colias eurytheme</i>	alfalfa butterfly	COLEUR	PIPE	HOME
<i>Colias philodice</i>	clouded sulfur	COLPHI	PIPE	HOME EFMO
<i>Danaus plexippus</i>	monarch	DANPLE	PIPE	HOME EFMO
<i>Euptoieta claudia</i>	variegated fritillary	EUPCLA	PIPE	HOME
<i>Everes comyntas</i>	eastern-tailed blue	EVECOM	PIPE	HOME
<i>Hemiargus isola</i>	Mexican blue	HEMISO	PIPE	HOME
<i>Hylephila phyleus</i>	fiery skipper	HYLPHY	WICR	
<i>Leptotes cassius</i>	tropical striped blue	LEPCAS		
<i>Leptotes marina</i>	striped blue	LEPMAR		
<i>Limenitis archippus</i>	viceroy	LIMARC		EFMO
<i>Nymphalis antiopa</i>	mourning cloak	NYMANT		EFMO
<i>Pholisora cattulus</i>	common sooty wing	PHOCAT	WICR	
<i>Phyciodes tharos</i>	pearl crescent	PHYTHA	PIPE	HOME EFMO
<i>Pieris rapae</i>	cabbage	PIERAP	PIPE	HOME
<i>Precis coenia</i>	buckeye	PRECOE	WICR	EFMO
<i>Pyrgus communis</i>	checkered skipper	PYRCOM		
<i>Speyeria cybele</i>	great spangled fritillary	SPECYB	WICR	HOME EFMO
<i>Strymon melinus</i>	grey hairstreak	STRMEL	WICR	HOME EFMO
<i>Vanessa atalanta</i>	red admiral	VANATA	PIPE	HOME EFMO

Table 5. Continued.

Species	Common name	Taxon code	Parks where present	
Open habitat generalist species (continued)				
<i>Vanessa virginiensis</i>	American painted lady	VANVIR	WICR	EFMO
<i>Wallengrenia egeremet</i>	broken dash	WALEGE	PIPE	EFMO
Grassland specialist species				
<i>Atrytona logan</i>	Delaware skipper	ATRLOG	WICR	HOME
<i>Chlosyne gorgone</i>	gorgone checkerspot	CHLGOR		HOME
<i>Coenonympha tullia</i>	ringlet	COETUL		
<i>Colias cesonia</i>	dog face	COLCES	PIPE	
<i>Erynnis martialis</i>	mottled dusky wing	ERYMAR		
<i>Eurema lisa</i>	little sulfur	EURLIS		HOME
<i>Eurema nicippe</i>	sleepy orange	EURNIC	WICR	HOME
<i>Harikenclenus titus</i>	coral hairstreak	HARTIT	WICR	
<i>Lycaena hyllus</i>	bronze copper	LYCHYL		HOME
<i>Nastra lherminier</i>	swarthy skipper	NASLHE		
<i>Papilio polyxenes</i>	black swallowtail	PAPPOL	PIPE	
<i>Phoebis sennae</i>	cloudless sulfur	PHOSEN	WICR	
<i>Pieris protodice</i>	checkered white	PIEPRO	WICR	HOME
<i>Plebejus melissa</i>	Melissa blue	PLEMEL		HOME
<i>Polites peckius</i>	Peck's skipper	POLPEC		
<i>Polites themistocles</i>	tawny edged skipper	POLTHE	WICR	HOME
<i>Speyeria atlantis</i>	atlantis fritillary	SPEATL	PIPE	
<i>Thorybes bathyllus</i>	southern cloudy wing	THOBAT	PIPE	
Prairie obligate species				
<i>Atrytonopsis hianna</i>	dusted skipper	ATRHIA	WICR	
<i>Hesperia ottoe</i>	prairie skipper	HESOTT		

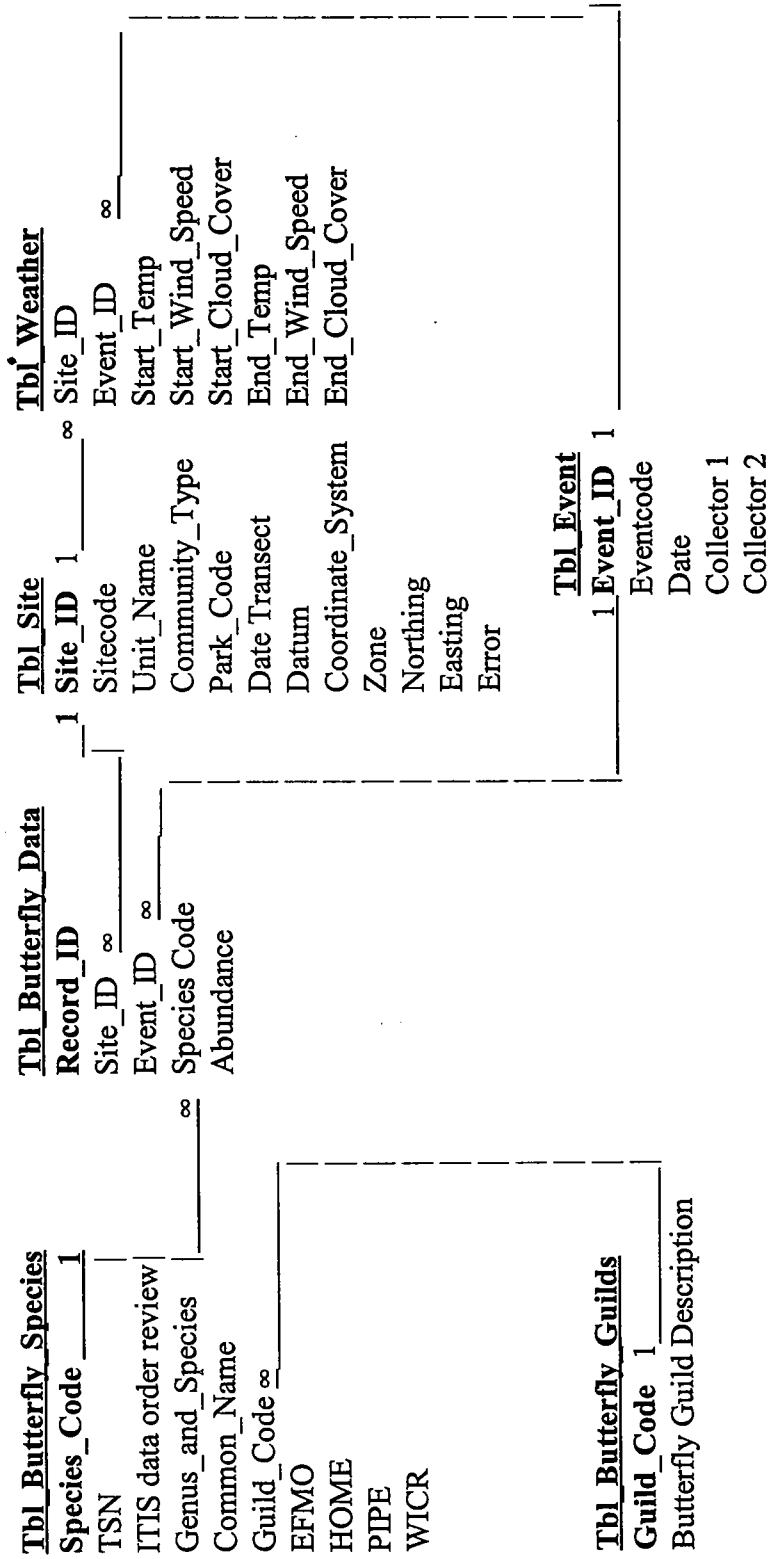
Table 5. Continued.

Species	Common name	Taxon code	Parks where present	
Prairie obligate species (continued)				
<i>Polites origenes</i>	crossline skipper	POLORI		
<i>Boloria bellona</i>	meadow fritillary	BOLBEL		
<i>Hesperia dacotae</i>	Dakota skipper	HESDAC		
<i>Oarisma powesheik</i>	powesheik skipper	OARPOW	PIPE	EFMO
<i>Problema byssus</i>	byssus skipper	PROBYS		EFMO
<i>Speyeria aphrodite</i>	aphrodite fritillary	SPEAPH	PIPE	EFMO
<i>Speyeria idalia</i>	regal fritillary	SPEIDA	PIPE	EFMO
<i>Hesperia leonardus</i>	Leonard's skipper	HESLEO	WICR	HOME
Woodland species				
<i>Achalarus lyciades</i>	hoary edge	ACHLYC		
<i>Anaea andria</i>	goatweed	ANEAND		
<i>Ancyloxypha numitor</i>	least skipperling	ANCNUM	WICR	
<i>Asterocampa celtis</i>	hackberry	ASTCEL	PIPE	
<i>Asterocampa clyton</i>	tawny emperor	ASTCLY	WICR	EFMO
<i>Battus philenor</i>	pipevine	BATPHI		
<i>Cercyonis pegala</i>	common wood nymph	CERPEG	WICR	
<i>Erynnis horatius</i>	Horace's dusky wing	ERYHOR	HOME	
<i>Euphyes vestris</i>	dun skipper	EUPVES	WICR	
<i>Staphylus hayhurstii</i>	southern scalloped		PIPE	
	sootywing	STAHAY		
<i>Leithe portlandia</i>	pearl eye	LETPOR	WICR	
<i>Limenitis arthemis</i>	viceroy	LIMART	WICR	
<i>Megisto cymela</i>	wood satyr	MEGCYM	WICR	EFMO
<i>Papilio glaucus</i>	tiger swallowtail	PAPGLA	WICR	HOME
<i>Papilio cresphontes</i>	giant swallowtail	PAPCRE	WICR	EFMO

Table 5. Continued.

Species	Common name	Taxon code	Parks where present
Woodland species (continued)			
<i>Papilio troilus</i>	spicebush swallowtail	PAPTRO	WICR
<i>Poanes hobomok</i>	hobomok skipper	POAHOB	WICR
<i>Poanes zabulon</i>	zabulon skipper	POAZAB	WICR
<i>Polytonia comma</i>	comma	POLCOM	WICR
<i>Polytonia interrogationis</i>	question mark	POLINT	WICR
<i>Polytonia progne</i>	gray comma	POLPRO	
<i>Satyrium calanus</i>	banded hairstreak	SATCAL	EFMO
<i>Satyrium liparops</i>	striped hairstreak	SATLIP	EFMO
Wetland specialist species			
<i>Calephelis muticum</i>	metalmark	CALMUT	WICR
<i>Euphydryas phaeton</i>	Baltimore checkerspot	EUPPHA	WICR
<i>Lethe eurydice</i>	northern pearl eye	LETEUR	PIPE
<i>Polites mystic</i>	long dash	POLMYS	PIPE
Savanna specialist species			
<i>Callophrys gryneus</i>	olive hairstreak	CALGRY	WICR
<i>Calycopis cecrops</i>	red banded hairstreak	CALCEC	WICR
<i>Epargyreus clarus</i>	hoary edge	EPACLA	WICR
<i>Lethe anthedon</i>	wild indigo duskywing	LETANT	
<i>Libytheana carinenta</i>	snout butterfly	LIBCAR	WICR
<i>Thorybes pylades</i>	northern cloudywing	THOPYL	WICR
<i>Satyrium edwardsii</i>	Edward's hairstreak	SATEDW	EFMO
			EFMO
			EFMO
			EFMO
			EFMO

Table 6. An example of an Access database and its tables and linkages for storage and handling of the butterfly monitoring data.



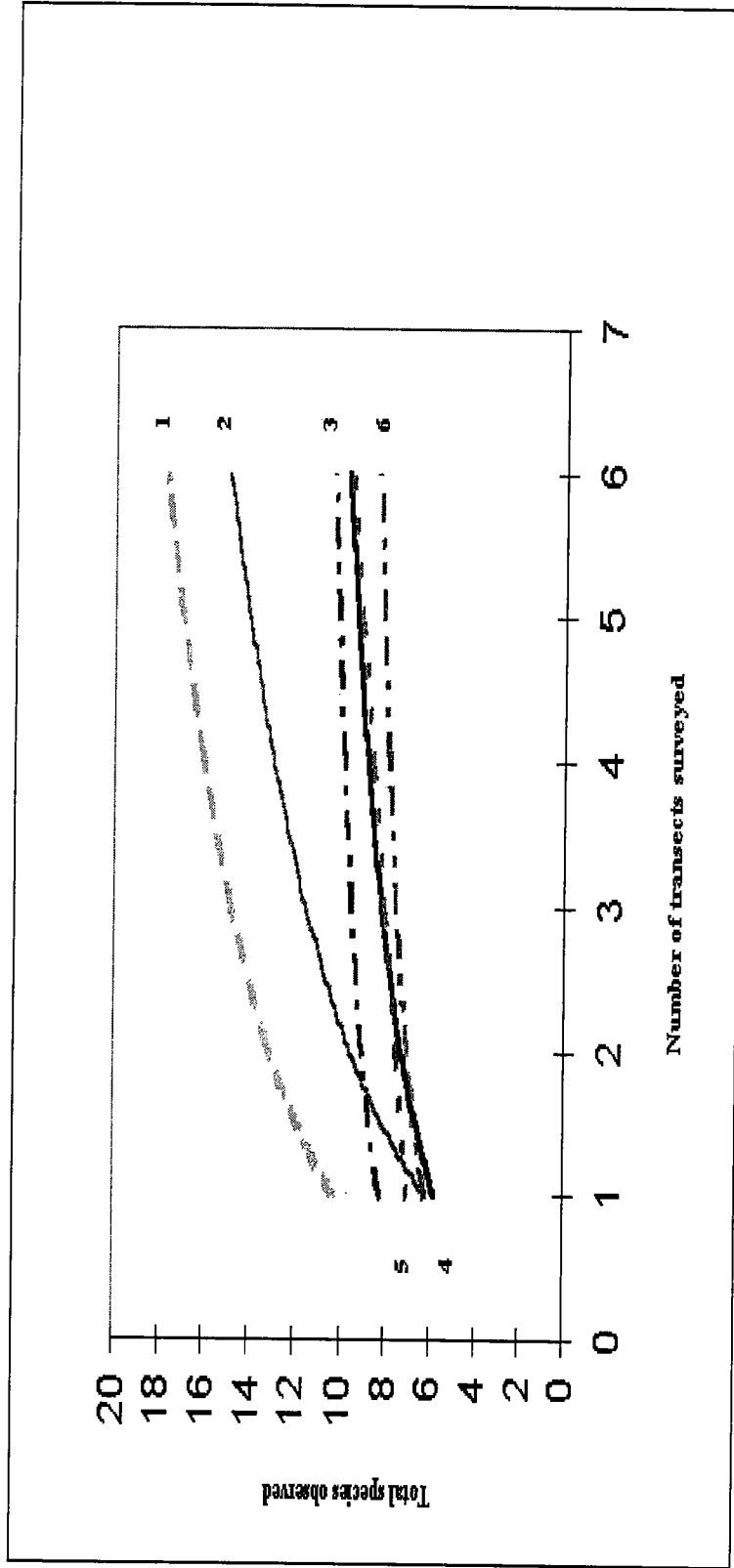


Figure 1. Number of butterfly species recorded vs. number of transects sampled for 6 prairies. Prairie designations, followed by prairie area in ha are:

1. Tallgrass Prairie National Preserve (12120)
2. Konza prairie (3473)
3. Homestead National Monument of America, schoolhouse prairie (0.2)
4. Warner Park prairie 1 (12.1)
5. Warner Park prairie 2 (0.8)
6. Washington prairie (16.2)

APPENDIX A. Locations of butterfly monitoring transects in three parks of the Prairie Cluster Program. Transect locations for Effigy Mounds National Monument are not available. 999 indicates no data.

Tran D	TranCode	Unit Name	Community Type	Park	Established	Datum	Coordinate System	Zone	Northing	Easting	Error	Elevation
1	BH1	BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS	15S	4106351	463446	0	363
2	BH2	BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS	15S	4106338	463468	0	363
3	BH3	BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS	15S	4106366	463461	0	363
4	BH4	BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS	15S	4106436	463483	0	0
5	BH5	BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS	15S	4106429	463453	0	0
6	BH6	BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS	15S	4106417	463436	0	0
7	BH7	BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS		999	999	0	0
8	BH8	BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS		999	999	0	0
9	NBH1	NORTH BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS		999	999	0	0
10	NBH2	NORTH BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS		999	999	0	0
11	NBH3	NORTH BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS		999	999	0	0
12	NBH4	NORTH BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS	15S	4106910	463591	0	0
13	NBH5	NORTH BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS		999	999	0	0
14	NBH6	NORTH BLOODY HILL	GLADE	WICR	05/29	NAS-C	UTM/UPS	15S	4106882	463571	0	0
15	NBH7	NORTH BLOODY HILL	GLADE	WICR	05/30	NAS-C	UTM/UPS		999	999	0	0
16	NBH8	NORTH BLOODY HILL	GLADE	WICR	05/30	NAS-C	UTM/UPS		999	999	0	0
17	HOME1	HOMESTEAD	TALLGRASS PRAIRIE	HOME	06/10	NAS-C	UTM/UPS	14T	4461392	683963	0	0
18	HOME2	HOMESTEAD	TALLGRASS PRAIRIE	HOME	06/10	NAS-C	UTM/UPS	14T	4461424	684070	0	0
19	HOME3	HOMESTEAD	TALLGRASS PRAIRIE	HOME	06/09	NAS-C	UTM/UPS	14T	4461402	684112	0	0

20	HOME4	HOMESTEAD	TALLGRASS PRAIRIE	HOME	06/09	NAS-C	UTM/UPS		999	999	0	
21	HOME5	HOMESTEAD	TALLGRASS PRAIRIE	HOME	06/10	NAS-C	UTM/UPS	14T	4461561	684154	0	
22	HOME6	HOMESTEAD	TALLGRASS PRAIRIE	HOME	06/10	NAS-C	UTM/UPS	14T	4461751	684146	0	
23	PIPE1	PIPESTONE	TALLGRASS PRAIRIE	PIPE	06/26	NAS-C	UTM/UPS	14T	4876913	714494	0	
24	PIPE2	PIPESTONE	TALLGRASS PRAIRIE	PIPE	06/26	NAS-C	UTM/UPS	14T	4877003	714551	0	
25	PIPE3	PIPESTONE	TALLGRASS PRAIRIE	PIPE	06/26	NAS-C	UTM/UPS	14T	4876879	714546	0	
26	PIPE4	PIPESTONE	TALLGRASS PRAIRIE	PIPE	06/26	NAS-C	UTM/UPS	14T	4876879	714623	0	
27	PIPE5	PIPESTONE	TALLGRASS PRAIRIE	PIPE	07/01	NAS-C	UTM/UPS	14T	4876484	714429	0	
28	PIPE6	PIPESTONE	TALLGRASS PRAIRIE	PIPE	07/01	NAS-C	UTM/UPS	14T	4876297	714399	0	
29	PIPE7	PIPESTONE	TALLGRASS PRAIRIE	PIPE	06/27	NAS-C	UTM/UPS		999	999	0	
30	PIPE8	PIPESTONE	TALLGRASS PRAIRIE	PIPE	06/27	NAS-C	UTM/UPS		999	999	0	
32	PIPE WITH ORCHIDS	PIPE UNIT 2 WITH ORCHIDS	TALLGRASS PRAIRIE	PIPE	08/14	NAS-C	UTM/UPS		999	999	0	
33	PIPE WITH ORCHIDS	PIPE UNIT 2 WITH ORCHIDS	TALLGRASS PRAIRIE	PIPE	08/14	NAS-C	UTM/UPS		999	999	0	
34	PIPE WITH ORCHIDS	PIPE UNIT 2 WITH ORCHIDS	TALLGRASS PRAIRIE	PIPE	08/14	NAS-C	UTM/UPS		999	999	0	
35	PIPE RESTORED PRAIRIE	PIPE RESTORED PRAIRIE	TALLGRASS PRAIRIE	PIPE	07/01	NAS-C	UTM/UPS		999	999	0	

36	PIPE REST2	PIPE RESTORED PRAIRIE	TALLGRASS PRAIRIE	PIPE	08/13	NAS-C	UTM/UPS		999	999	0	
37	PIPE REST10A	PIPE RESTORED PRAIRIE	TALLGRASS PRAIRIE	PIPE	07/01	NAS-C	UTM/UPS		999	999	0	
38	PIPE REST10B	PIPE RESTORED PRAIRIE	TALLGRASS PRAIRIE	PIPE	07/01	NAS-C	UTM/UPS		999	999	0	
39	PIPE REST9A	PIPE RESTORED PRAIRIE	TALLGRASS PRAIRIE	PIPE	07/01	NAS-C	UTM/UPS		999	999	0	
40	PIPE REST9B	PIPE RESTORED PRAIRIE	TALLGRASS PRAIRIE	PIPE	07/01	NAS-C	UTM/UPS		999	999	0	
41	PIPE SOUX1	PIPE SOUX QUARTZITE	GLADE	PIPE	08/13	NAS-C	UTM/UPS		999	999	0	
42	PIPE SOUX2	PIPE SOUX QUARTZITE	GLADE	PIPE	08/13	NAS-C	UTM/UPS		999	999	0	
43	RAY1	WICR RAY HOUSE	TALLGRASS PRAIRIE	WICR	07/18	NAS-C	UTM/UPS		999	999	0	
44	RAY2	WICR RAY HOUSE	TALLGRASS PRAIRIE	WICR	07/18	NAS-C	UTM/UPS		999	999	0	
45	SCHOOL 1	HOME SCHOOL HOUSE	TALLGRASS PRAIRIE	HOME	06/10	NAS-C	UTM/UPS	14T	4462271	683481	0	
46	SCHOOL 2	HOME SCHOOL HOUSE	TALLGRASS PRAIRIE	HOME	06/10	NAS-C	UTM/UPS	14T	4462269	683475	0	
47	SCHOOL 3	HOME SCHOOL HOUSE	TALLGRASS PRAIRIE	HOME	06/10	NAS-C	UTM/UPS	14T	4462267	683468	0	
48	SCHOOL 4	HOME SCHOOL HOUSE	TALLGRASS PRAIRIE	HOME	06/10	NAS-C	UTM/UPS	14T	4462268	683460	0	

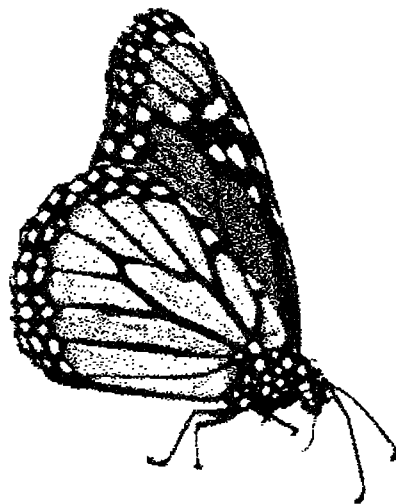
APPENDIX B. Annual report on butterfly monitoring at Homestead National Monument of America.



**Prairie Cluster Long-Term
Ecological Monitoring Program**

**Program Report
00-001**

**Status Report:
1997-1998 Butterfly Monitoring at
Homestead National Monument of America**



Status Report:

1997-1998 Butterfly Monitoring at
Homestead National Monument of America

by

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August 2000

1.0 INTRODUCTION

1.1 Background

Only about 1% of the original tallgrass prairie ecosystem of the U.S. still remains (Swengel 1996). The drastic loss of prairie habitat, the disruption of natural disturbance regimes and nutrient cycles, and the isolation of the remaining tallgrass prairie habitat make the preservation of prairie-dependent species a unique challenge (Johnson and Simberloff 1974; Leach and Givnish 1996; Collins et al. 1998; Kaiser 1998; Schlicht and Orwig 1998). The butterfly communities of tallgrass prairie remnants are indicators of impacts on a broader spectrum of invertebrate species (New et al. 1995). Monitoring butterfly communities offers several advantages: 1) Their habitat preferences and host plant associations are relatively well-known, which allows classification of individual species into guilds (Sharp et al. 1974; Scott 1986; Opler and Malikul 1992; Panzer et al. 1995; Swengel 1996; 1998); 2) A large literature exists on metapopulation dynamics, dispersal, and the effects of different habitats on butterfly movement behavior (Sharp et al. 1974; Fahrig and Paloheimo 1987; Hanski et al. 1995; Hanski et al. 1996; Hill et al. 1996; Neve et al. 1996; Peterson 1997; Haddad 1999); and 3) Obligate prairie species respond quickly to changes in native vegetation (Miller and Harris 1977; Saunders et al. 1991).

In 1997 and 1998, a butterfly species inventory was carried out in Homestead National Monument of America (HOME) in Nebraska (Mahady and Debinski 1999). This inventory supplied the data for this report. Two habitat types, restored prairie and schoolhouse native prairie, were sampled at HOME (Mahady and Debinski 1999). In 1997, 3 transects in the restored prairie were sampled in June and 6 in July, and 6 transects were sampled in June and July of 1998. In the schoolhouse native prairie, 6 transects were sampled in June and July of 1997, and 8 transects were sampled in June and July of 1998.

1.2 Objectives

The objectives of butterfly monitoring at HOME are: 1) to determine changes in the abundance and species richness of each butterfly species guild by site, and 2) to compare abundance and species richness of the butterfly species guilds between native and restored prairie areas.

2.0 METHODS

2.1 Field procedures

All butterfly monitoring procedures are described in detail in Debinski et al. (2000). Transects (5-m wide by 50-m long) were surveyed by a single observer walking down the middle of the transect at a constant pace of 10 m per minute. Most butterflies were identified to species in flight. Individual butterflies that could not be identified in flight were captured using a butterfly net and then identified. Each transect was surveyed 6 times during a sampling visit. A minimum of 15 minutes elapsed between transect counts to allow the butterfly community to recover from the disturbance of the previous sample. Abundance of each species that occurred on a transect was recorded on a data sheet.

2.2 Abundance and species richness of prairie obligate species

Using the count data sheets, each butterfly species were assigned to a species guild (Table 1), and the abundance of individuals within each guild was calculated for each transect count. Species richness was then calculated as the sum of the total number of species within each guild for each transect count. After testing for compliance with the assumptions of analysis of variance, the abundance and species richness data were analyzed between years by analysis of variance for each species guild and site using SAS system statistical analysis software (SAS Institute Inc. 1989-1996). However, because only 2 woodland guild species and 1 prairie obligate guild species were recorded at HOME (Table 1), these groups were excluded from analyses of species richness, because little biological meaning could be ascribed to the findings. In addition to the interannual comparisons, analysis of variance also was used on the total dataset to compare abundance and species richness between the restored and native prairie for each butterfly guild. Jaccards similarity index also was calculated for further comparison of the two habitats. The index is calculated as:

$$SC_j = c/(A + B - c),$$

where c is the number of species occurring in both habitats, A is the number of species occurring in habitat 1, and B is the number of species occurring in habitat 2. The index would have a value of 0 if there were no species in common, and a value of 1 would indicate that all observed species occurred at both sites.

3.0 RESULTS

Tables 2 and 3 show the abundance of each species found on the restored prairie and native prairie areas, respectively. Table 4 shows the results of the analyses of variance between years for each butterfly guild. At the restored prairie site, both the abundance and species richness of generalist butterfly species differed significantly ($P \leq 0.05$) between years. Both variables were much higher in 1998 than in 1997. However, at the native prairie site the abundance of the prairie obligate butterfly *Speyeria idalia*, the regal fritillary, was significantly greater in 1997 than in 1998.

The two prairie sites differed significantly ($P \leq 0.05$) in the abundance and species richness of generalist guild butterflies (Table 5). Values for both variables were higher in the native prairie than in the restored prairie. The Jaccard similarity index value for the generalist guild was 0.54, indicating that the species composition was not very similar between the sites. The Jaccard index also indicated that the two habitats were even more dissimilar in the composition of grassland specialist butterflies ($SC_j = 0.38$), even though the richness values were very similar (Table 5).

4.0 DISCUSSION

It is difficult to explain why the generalist butterfly guild species were less common and less diverse in 1997 than in 1998. Sampling effort was probably not a large factor because 9 transects were sampled in 1997 vs. 12 in 1998, both in excess of the number of transects needed

to encounter nearly all the species present (Debinski et al. 2000). Also, the number of sampling dates per year (2) was equal for both sites. Additionally, examination of the field conditions during collection (Table 6) do not suggest physical factors during sampling as a cause for the observed interannual differences. While flights of some species are brief but large (Mahady, personal communication, reported 101 sightings of the powesheik skipper at Pipestone National Monument on 27 June 1998, but none on 26 June 1997), most of these species are relatively common species over the entire sampling window (Richard and Heitzman 1987). Climatological factors may offer the best explanation for the differences.

In contrast, the single prairie obligate taxon was much more abundant at the native prairie site in 1997 despite less sampling in that year. At that site only 1 sample was taken early in 1997, so the actual difference in abundance may have been underestimated. After a June emergence, this species is typically present all summer in prairie habitats, so again, neither ephemeral flight periods, sampling intensity differences, nor physical weather conditions seem likely to explain the observed difference at this site. If climatological factors are the major factor explaining these results then the different guilds must respond differently to climate forcing.

The site comparisons indicate that the two prairies support much different abundances and species richness of the most common generalist butterfly group. Not only do the two sites differ in the diversity of generalist species, but the Jaccard index also shows that community composition of the generalist guild also is not very similar. In contrast, the grassland species guild has the same low diversity but even less similar species assemblages. Often the number of species recorded is a function of habitat area. Mahady (1999) found such significant relationships for butterflies in some geographic regions and for some guilds but none for the generalist or grassland + prairie obligate guilds occurring in the Flint Hills region, which includes HOME. Nevertheless, if this relationship had been found, it would have predicted greater species richness for the larger restored prairie. The results of the analyses of variance and the Jaccard indices seem more likely to be due to underlying differences in the plant communities. Mahady and Debinski (1999) noted that although native grass and forb diversity was generally good at both prairies, the restored prairie was impacted by invasion of woody species and exotic grasses and did not provide the abundance of nectar sources found at the smaller native prairie. Additional study would be required to determine if this is a function of differences in plant community composition between these sites.

Although the initial limited inventory sampling at HOME precludes the possibility of assessing causes and effects for these findings, this data does demonstrate the utility of using butterfly monitoring to assess ecosystem health. Only by continued monitoring can a dataset be assembled that will allow testing for long-term trends. For instance, Selser (1992) concluded that her prairie sites all appeared to have unique butterfly assemblages and suggested that the intricacies of the relationships between butterflies, forbs, and grasses would emerge only with continued monitoring. Thus, a butterfly monitoring program carried out in conjunction with plant community-(Buck et al. 2000) and weather-(Akyuz et al. 2000) monitoring programs can provide a powerful basis for using techniques of multivariate analysis to assess the causes and effects of findings.

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Table 1. Butterfly species recorded at Homestead National Monument of America, and classified by ecological guild.

Species	Common Name	Species	Common Name
<u>Open habitat generalist species</u>			
<i>Celastrina argiolus</i>	spring azure	<u>Prairie obligate species</u>	regal fritillary
<i>Colias eurytheme</i>	alfalfa butterfly	<i>Speyeria idalia</i>	
<i>Colias philodice</i>	clouded sulfur	<u>Woodland species</u>	common wood nymph tiger swallowtail
<i>Danaus plexippus</i>	monarch	<i>Cercyonis pegala</i>	
<i>Euptoieta claudia</i>	variegated fritillary	<i>Papilio glaucus</i>	
<i>Everes comyntas</i>	eastern-tailed blue		
<i>Hemiargus isola</i>	Mexican blue		
<i>Pholisora cattulus</i>	common sooty wing		
<i>Phyciodes tharos</i>	pearl crescent		
<i>Pieris rapae</i>	cabbage		
<i>Pyrgus communis</i>	checkered skipper		
<i>Speyeria cybele</i>	great spangled fritillary		
<i>Strymon melinus</i>	grey hairstreak		
<i>Vanessa atalanta</i>	red admiral		
<i>Vanessa cardui</i>	painted lady		
<i>Vanessa virginiensis</i>	American painted lady		
<u>Grassland specialist species</u>			
<i>Atrytone logan</i>	Delaware skipper		
<i>Chlosyne gorgone</i>	gorgone checkerspot		
<i>Erynnis martialis</i>	mottled dusky wing		
<i>Eurema lisa</i>	little sulfur		
<i>Lycaena hyllus</i>	bronze copper		
<i>Phoebis sennae</i>	cloudless sulfur		
<i>Pieris protodice</i>	checkered white		
<i>Polites peckius</i>	Peck's skipper		
<i>Polites themistocles</i>	tawny edged skipper		

Table 2. Species abundance for all sampled transects at the restored prairie of Homestead National Monument of America in 1997 and 1998. Nine transects were sampled in 1997 and 12 were sampled in 1998.

Species	Common Name	1997	1998
<i>Atrytone logan</i>	Delaware skipper	0	1
<i>Cercyonis pegala</i>	common wood nymph	6	6
<i>Colias eurytheme</i>	alfalfa butterfly	2	11
<i>Danaus plexippus</i>	monarch	2	4
<i>Everes comyntas</i>	eastern-tailed blue	6	8
<i>Papilio glaucus</i>	tiger swallowtail	1	1
<i>Pholisora cattulus</i>	common sooty wing	1	0
<i>Phyciodes tharos</i>	pearl crescent	2	6
<i>Polites themistocles</i>	tawny edged skipper	1	2
<i>Speyeria cybele</i>	great spangled fritillary	3	6
<i>Speyeria idalia</i>	regal fritillary	4	3
<i>Erynnis marialis</i>	mottled dusky wing	0	1
<i>Phoebis semnae</i>	cloudless sulfur	0	1
<i>Pyrgus communis</i>	checkered skipper	0	1
<i>Vanessa atalanta</i>	red admiral	0	1
<i>Vanessa virginiensis</i>	American painted lady	0	1

Table 3. Species abundance for all sampled transects at the schoolhouse native prairie habitat of Homestead National Monument of America in 1997 and 1998. Six transects were sampled in 1997, and 16 were sampled in 1998.

Species	Common Name	1997	1998
<i>Atrytone logan</i>	Delaware skipper	0	3
<i>Cercyonis pegala</i>	common wood nymph	3	6
<i>Colias eurytheme</i>	alfalfa butterfly	2	13
<i>Danaus plexippus</i>	monarch	6	9
<i>Euptoieta claudia</i>	variegated fritillary	5	8
<i>Everes comyntas</i>	eastern-tailed blue	6	16
<i>Lycaena hyllus</i>	bronze copper	6	4
<i>Pholisora cattulus</i>	common sooty wing	2	0
<i>Phyciodes tharos</i>	pearl crescent	0	8
<i>Polites themistocles</i>	tawny edged skipper	0	4
<i>Speyeria idalia</i>	regal fritillary	6	9
<i>Phoebis sennae</i>	cloudless sulfur	0	3
<i>Pyrgus communis</i>	checkered skipper	0	3
<i>Vanessa atalanta</i>	red admiral	0	1
<i>Pieris rapae</i>	cabbage butterfly	0	7
<i>Polites peckius</i>	Peck's skipper	0	2
<i>Chlosyne gorgone</i>	gorgone checkerspot	0	1
<i>Eurema lisa</i>	little sulfur	0	1
<i>Pieris protodice</i>	checkered white	0	1
<i>Strymon melinus</i>	grey hairstreak	0	2
<i>Vanessa cardui</i>	painted lady	0	1

Table 4. Results of analyses of variance for abundance and species richness between years for each butterfly guild occurring within Homestead National Monument of America.

Restored prairie		Mean \pm Standard deviation		FPROB	Result
Variable	Guild	1997	1998		
Abundance	Prairie obligate	2.5 \pm 1.3	1.3 \pm 0.6	0.2108	Not significant
	Generalist	3.6 \pm 2.7	17.2 \pm 11.7	0.0031	Significant
	Grassland specialist	1.0	1.8 \pm 1.0	0.5340	Not significant
	Woodland species	2.4 \pm 1.7	2.8 \pm 1.2	0.6358	Not significant
Species richness	Generalist	1.9 \pm 0.8	3.7 \pm 1.3	0.0014	Significant
	Grassland specialist	1.0	1.3 \pm 0.5	0.6850	Not significant
Schoolhouse native prairie		Mean \pm Standard deviation		FPROB	Result
Variable	Guild	1997	1998		
Abundance	Prairie obligate	7.3 \pm 4.3	1.2 \pm 0.4	0.0008	Significant
	Generalist	18.3 \pm 7.3	32.1 \pm 25.1	0.2069	Not significant
	Grassland specialist	2.0 \pm 1.5	2.7 \pm 2.5	0.5382	Not significant
	Woodland species	2.3 \pm 1.5	1.5 \pm 1.2	0.4011	Not significant
Species richness	Generalist	4.3 \pm 1.0	4.3 \pm 1.9	0.9803	Not significant
	Grassland specialist	1.0 \pm 0.0	1.5 \pm 0.7	0.1101	Not significant

Table 5. Results of analyses of variance comparing abundance and species richness, by species guild, between sites at Homestead National Monument of America. The two-year butterfly dataset was lumped for these analyses. RP = Restored prairie; NP = Schoolhouse native prairie

Variable	Guild	Mean \pm standard deviation		FPROB	Result
		RP	NP		
Abundance	Prairie obligate	2.0 \pm 1.2	3.7 \pm 4.0	0.3011	Not significant
	Generalist	11.1 \pm 11.1	28.4 \pm 22.5	0.0034	Significant
	Grassland specialist	1.6 \pm 0.9	2.5 \pm 2.2	0.3992	Not significant
	Woodland species	2.6 \pm 1.4	1.8 \pm 1.3	0.1799	Not significant
Species Richness	Prairie obligate	1.0 \pm 0.0	1.1 \pm 0.3	0.5079	Not significant
	Generalist	2.9 \pm 1.4	4.3 \pm 1.7	0.0057	Significant
	Grassland specialist	1.2 \pm 0.4	1.3 \pm 0.6	0.6849	Not significant
	Woodland species	1.8 \pm 1.5	3.0 \pm 3.0	0.2473	Not significant

Table 6. Physical field conditions during the transect surveys at Homestead National Monument of America.

Restored prairie				
Date	Transects	Temperature (°C)	Wind speed (km h ⁻¹)	Cloud cover (%)
9 June 1997	3	25.5	12	80
10 June 1997	1, 5	25.5-28.9	2-5	15-60
21 July 1997	1-2, 4-6	28.9-32.2	2-5	15-60
22 July 1997	3	32.2	5	60
12 June 1998	1-3	27.8	20-21	25-30
13 June 1998	4-6	25.5	5	0-5
28 July 1998	1-6	30.1	0	0
Schoolhouse native prairie				
Date	Transects	Temperature (°C)	Wind speed (km h ⁻¹)	Cloud cover (%)
22 July 1997	1-6	33.3	2	15
12 June 1998	1-8	27.2	8	30
28 July 1998	1-8	26.8-27.7	15	0-30

